

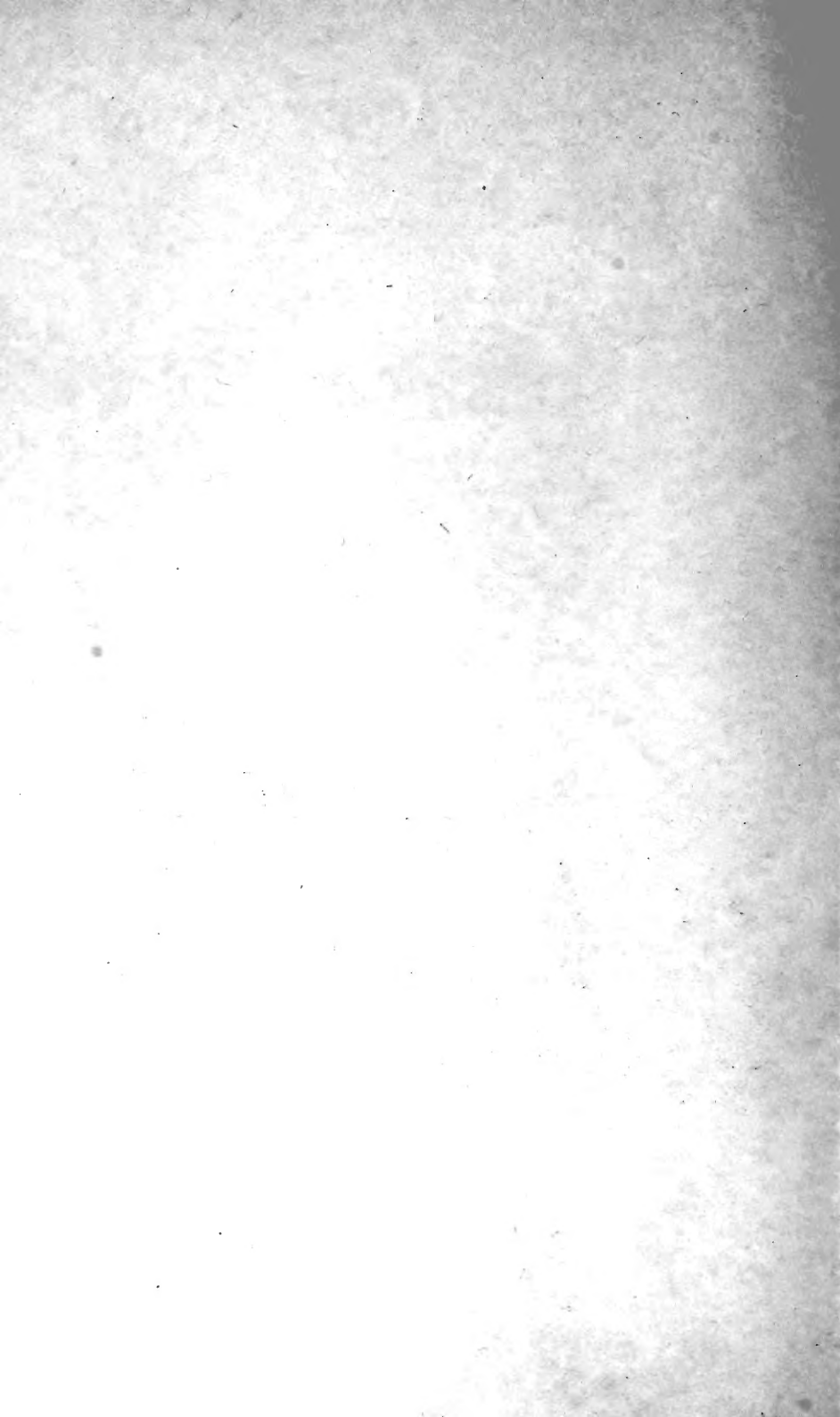
LOSSES TO COTTON

What to Look For and Where to Find It

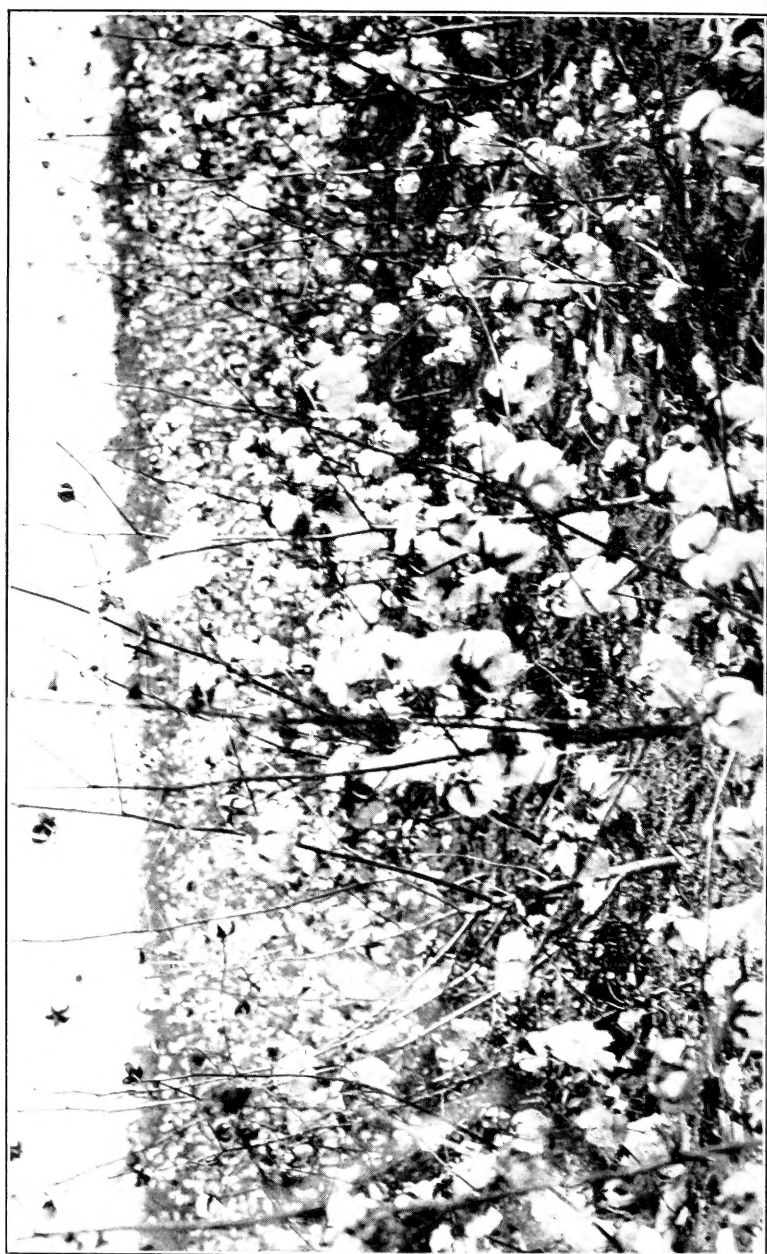
Being one of a series of articles in relation to crops, their common diseases, and insect pests to which they are subject



Published by
HAIL DEPARTMENT
Western Adjustment & Inspection Co.
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COTTON

The raw material of our most important manufacturing enterprises and export trade, the nature and special characteristics of its growth.

“Knowledge directeth practice and
practice increaseth knowledge.”

INTRODUCTORY

Cotton furnishes the raw material for one of our most important manufacturing industries, and from one-fourth to one-third of our total exports.

Its economic importance is far beyond numerical expression, for, while the total crop of the world is approximately ascertainable, the effect of cotton upon the commercial and social relations of mankind is too far-reaching for estimation. Of the four great staples that provide man with clothing—cotton, silk, wool and flax—cotton, by reason of its cheapness and its many excellencies is rapidly superseding its several rivals. Fifty years ago, only about 2,500,000 bales of cotton, or less than the present production of Texas, were annually converted into clothing.

Cotton stands pre-eminent among farm crops in the ease and cheapness of its production as compared with the variety and value of its products. It is less subject to the ravages of insects than any other of the staple crops, and no crop makes so slight a drain upon the fertility of the soil.

Modern enterprise has found more uses for the several parts of the cotton plant than have been discovered in any other farm crop. The cotton plant produces, in fact, a double crop: (1) a most beautiful fiber and (2) seed—yielding both oil and feed—which, although neglected for a long time, is now valued at one-fourth as much as the raw cotton. In addition to this, the stems are made to yield a fiber, which waits only for a machine to work it, and the roots yield a drug.

PART I

INSECTS

There are many insects which derive their food from the cotton plant. This list as a whole comprises about 465 species. But a small portion of these, however, can be considered as injurious to cotton, and still fewer numbers have attracted the attention of cotton-planters by their injuries to the crop. Many of them are enemies of, and prey upon, species which damage the plant, while many others are accidental visitors to the cotton fields and might have been found as readily in the fields of corn or in other crops in the same general locality.

The Cutworm

The first insect to attack the young cotton plant in the spring is the cutworm. Soon after the young plants come up and often after they are fairly well grown, they are likely to be cut off at the surface of the ground by one of



THE COTTON CUTWORM

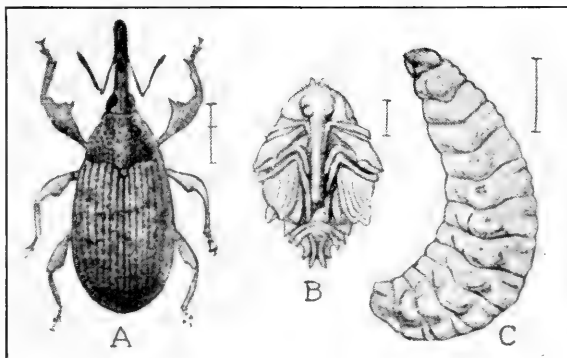
Adult and larva. Natural size.

these caterpillars, all of which have the habit of hiding beneath the surface of the ground during the day and coming out to work at night. The granulated cutworm is probably the most common of the species and is known as the cotton

cutworm. A number of other species of cutworms are undoubtedly concerned in the damage, however.

The Boll Weevil

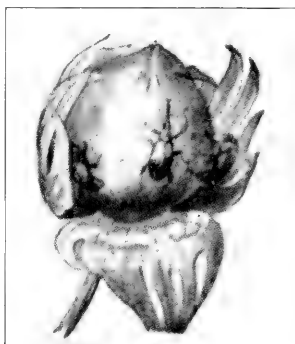
The adult boll weevil is about one-quarter of an inch in length, varying from one-eighth to one-third of an inch, with a breadth of about one-third of the length. This



THE COTTON BOLL WEEVIL

(a) adult beetle; (b) pupa; (c) larva. Enlarged.

measurement includes the snout, which is about one-half the length of the body. The color (grayish or brownish) depends upon the time that may have elapsed after trans-



COTTON BOLL WEEVIL

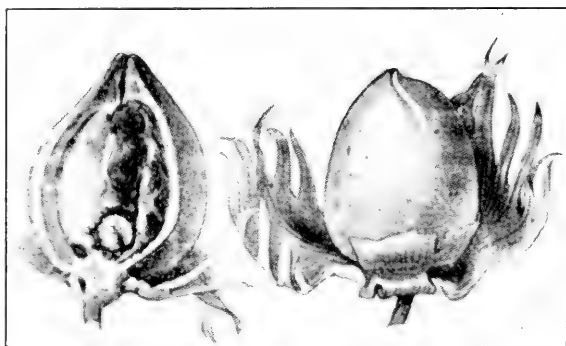
Late fall boll, showing how beetles hide between boll and inclosure.

formation to the adult stage. The recently emerged individuals are light yellowish in color, but pass to a gray or nearly black shade in a few weeks' time.

In the field the most conspicuous indication of the presence of the boll weevil is the flaring and falling of great numbers of squares. However, unfavorable climatic conditions and careless cultivation frequently cause much shedding. If excessive shedding be noticed and the squares upon being cut open show a white, curved grub that has fed upon the contents, there is little doubt that the boll weevil is the insect causing the damage.

The boll weevil passes the winter in the adult stage. In the spring and throughout the fruiting season of cotton the eggs are deposited by the female weevils in the cavities formed by eating into the fruit of the plant.

The squares are greatly preferred as food and as places for depositing eggs. As long as a large supply of squares is present the bolls are not damaged to any serious extent.



COTTON BOLL WEEVIL

Mature boll cut open at left, showing full-grown larva; the one at the right not cut, and showing feeding punctures and oviposition marks.

The bolls, therefore, have a fair chance to develop as long as squares are being formed. Whenever frost or other unfavorable weather causes the plants to cease putting on squares, the weevils attack the bolls.

The cotton boll weevil, so far as known at present, has no food plant other than cotton.

In the fall when frosts occur, immature stages of development of the boll weevil may be found in the squares or bolls. Provided food supply is sufficient, many of these immature stages continue their development at a very slow rate and adults finally emerge. Thus there may be a somewhat continuous production of adults during the winter.

Ordinarily, however, this is not conspicuously the case, since the frosts that destroy the cotton generally kill practically all of the immature stages of the weevil.

The Cotton Boll Worm, or Corn Ear Worm

The boll worm is the common greenish or brownish worm that eats into the bolls of cotton and the ears of both field and sweet corn. Its eggs are usually laid in the top of



TRANSFORMATION OF COTTON BOLL WORM

- (1) Egg on underside of cotton leaf; (2) larva one-third grown boring into square; (3) entrance hole of young larva in square, with excremental pellets at edge of hole; (4) nearly full-grown larva just issued from boll; (5) full-grown larva on leaf stem; (6) pupa shown in center of underground earthen cell; cell shown in longitudinal section; (7) adult moth, light variety; (8) adult moth with light fore-wings; (9) adult moth in resting position, wings slightly elevated, hind border of hind wings slightly showing.

the boll, and the young larva soon begins to feed, eating into the cotton at the tip of the boll. As it grows it tunnels down into the boll, burrowing only a part of the lock, yet injuring the whole fiber.

The boll worm spends the winter in the pupa state in the ground. Sometimes in late spring, in May or June, the adult moths emerge and deposit their eggs on the cotton and corn.

Mature larva measure about one and one-half inches in length. The moth, a rather stout insect, measures three-fourths of an inch in length. The larvae vary in color from light green to brown, being more or less striped in appearance, with alternating light and dark lines.

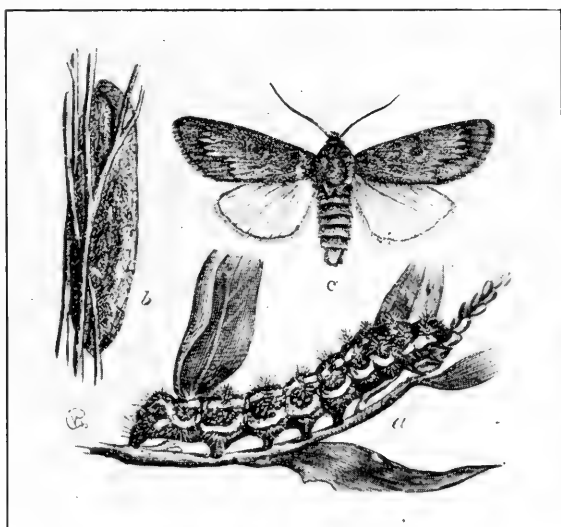
The Cotton Leaf Worm, the Cotton Army Worm or Cotton Caterpillar

The cotton caterpillar, the cotton army worm or cotton leaf worm, a slender, bluish-green caterpillar with small, black spots and often with black stripes down its back, which loops when it crawls and feeds voraciously on both upper and under surfaces of the cotton leaf, is to be found in cotton fields in the Gulf states all through the summer. It is generally unnoticed in the early part of the season on account of the insignificance of its number. Later, through the ragging of the leaves, it becomes noticeable, and in seasons of abundance the cotton plant is entirely defoliated. Farther north the insect makes its appearance later in the season, and there the caterpillars are not the offspring of the hibernating moths, but of the moths of the first or second generations, which have developed in cotton fields farther south and have flown north with the prevailing southern winds. There is no absolute evidence of these insects having any other food plants than cotton, although many entomologists have suspected that the species have a northern host plant.

The egg is bluish-green in color and of a different shade from that of the leaf, so that it can be readily distinguished. It is flattened, convex in shape, with many parallel, longitudinal ridges converging at the center above. It is found usually on the under side of the leaves and, as a general thing, toward the top of the plant. As many as five hundred eggs are laid by each female, sometimes several upon one leaf, but never in clusters. The eggs are laid at night, since the moth is a night flyer. In mid-summer the larva hatches in from three to four days after the egg is laid, but in spring and autumn this period is very

considerably lengthened. After hatching from the egg, the young larva feeds at first upon the under side of the leaf, devouring simply the lower part and not passing through to the upper side until after the first molt. At first the larva is pale yellow in color, but soon becomes greenish.

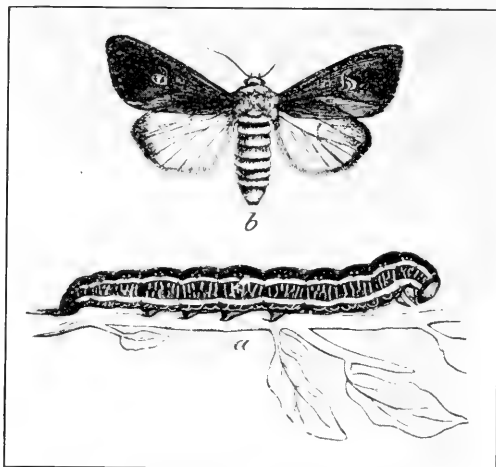
Before reaching full growth, the caterpillar sheds its skin five times, the duration of the caterpillar stage being from one to three weeks. Early in the season the green



THE SMARTWEED CATERPILLAR
(a) larva; (b) cocoon; (c) adult. Natural size.

color appears to predominate, while toward fall the blackish caterpillars are more abundant, although at any time during the season green and dark worms are seen together. Although the normal food of the caterpillar is the leaves, it will frequently gnaw the tender twigs, but will very rarely damage the bolls by eating into them, and then only in spots. This contingency, however, generally occurs only when the worms are present in exceptional numbers and the supply of leaves becomes exhausted. It is somewhat of a cannibal and, when other food fails, or even rarely when leaves are abundant, it will feed upon smaller and weaker individuals of its own kind. In spite of its comparatively small size and slender form, this larva is unusually greedy and when occurring in numbers, completely ruins the cotton crop.

It spins a light silken web, forming an imperfect cocoon, usually within a folded leaf. It is frequently seen hanging quite naked upon the plant, but in such cases the

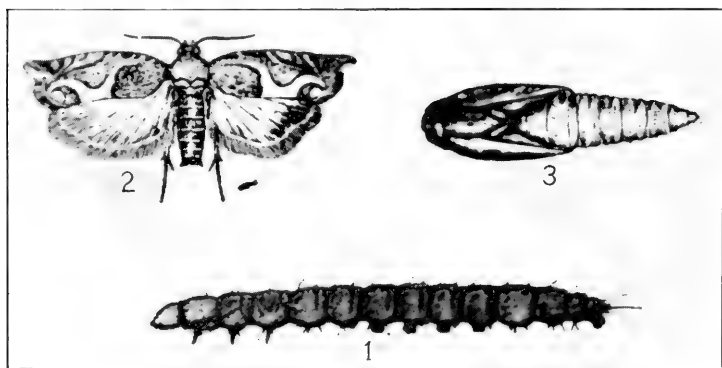


THE ZEBRA CATERPILLAR
(a) larva; (b) adult. Natural size.

leaf in which it was originally spun has been eaten away by other caterpillars.

Leaf-Feeding Caterpillars

There are many species of larva which feed upon the leaves of the cotton plant. Few of these, however, are strictly confined to this plant for food. One of the most



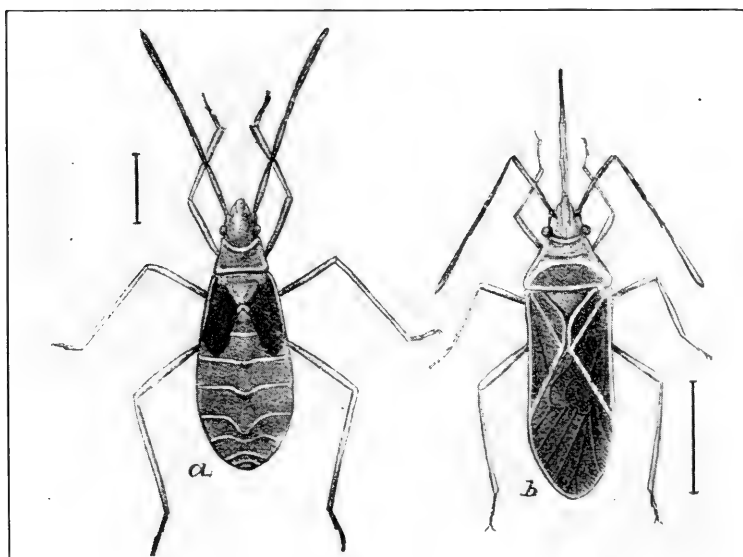
LEAF ROLLER
1 Caterpillar; 2 moth; 3 pupa.

commonly noted is known, from its work, as the leaf roller, a title under which another species may also be included. Both species are general feeders and are found in various parts of the country, the former upon apple, peach, cherry, clover, honeysuckle, beans, strawberries, and other plants, and the latter upon clover and grass. The larva of the former, in addition to the folding of the leaves of cotton and feeding within the roll, sometimes bore into the young bolls, although this method of damage is rare.

The royal horn caterpillar, sometimes known as the hickory horn devil, a very large, green caterpillar with long recurved red horns, the large green, somewhat hairy larva of the imperial moth and the large spiny larva, also feeds upon cotton. The results of the work of these different species are identical. Two bag worms are also occasionally found feeding upon cotton leaves, constructing their cases from fragments of the leaves sewed together with silk. These are the common bag worm of the north.

Insects Injuring the Boll

Numerous species of insects are found in damaged bolls which are the results rather than the cause of the



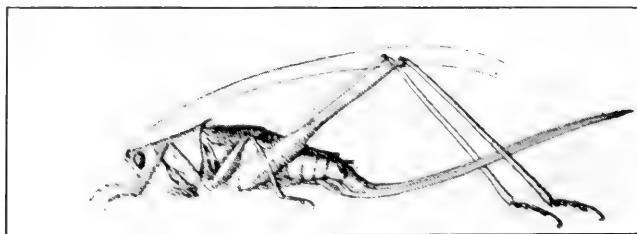
THE RED BUG OR COTTON STAINER
(a) pupa; (b) adult. Enlarged.

damage. There is a class of damage to the bolls which is known to planters as sharp-shooter work, which is mainly caused by the punctures of a leaf hopper. This insect is most abundant from the first of June on through the season. Prior to the first of June it seems to prefer the young growth and foliage of poplars and other trees which may grow in the immediate vicinity.

Still another insect which at times does considerable damage to cotton bolls, particularly those which are far advanced or have opened, is the red bug or cotton stainer. This insect is not known to be prevalent except in Florida and Georgia and neighboring portions of South Carolina and Alabama. The insect does its damage by puncturing the bolls and sucking the sap, causing them to become diminutive or to remain immature. Later, however, the insect may enter open bolls, puncturing the seed and damaging the fiber by its yellowish excretions.

Grasshoppers

Grasshoppers are considered one of the most common class of insects which do injury to the foliage of the cotton plant. Several species of grasshoppers have this habit, and



THE SMALLER MEADOW GRASSHOPPER

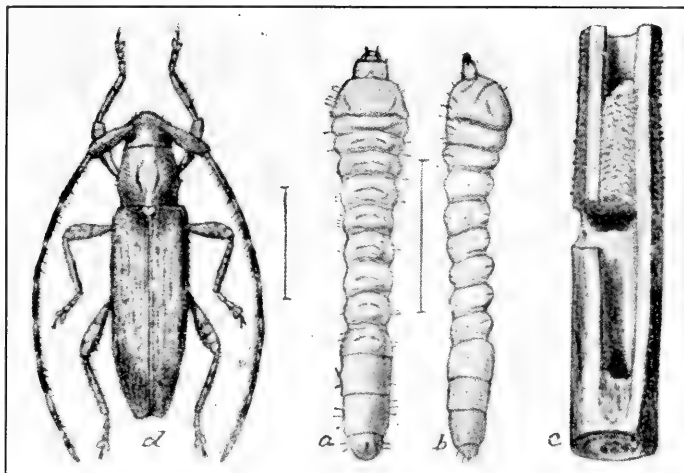
the list of cotton insects contains the names of fourteen grasshoppers which are found upon the plants. The damage which the grasshopper causes to the foliage of cotton is similar to that of the bag worm and the hickory horn devil.

The Cotton Stalk-Borer

Puncturing of the terminal portion of the stalk by plant bulk occasionally occurs, but is comparatively rare. There is but one borer of the stalks of cotton, and that is the long-horned beetle known as the cotton stalk-borer. It is occasionally mistaken for a direct enemy of the plant,

but investigation has shown that it lays its eggs upon, and its larva bore into, only such stalks as have been damaged by some other cause, such as rust. It follows injury to the plant, therefore, rather than causes it.

There is only one brood of these insects a year, and they commonly reach maturity in the middle of August.



THE COTTON STALK BORER

(a) larva from above; (b) larva from side; (c) tunneled cotton stalk, showing exit hole; (d) adult beetle. All enlarged except c.

They frequently pupate in the stalk, especially in the case of large, hollow stalks, but sometimes burrow a short distance into the ground for pupation. The adult is a moth of a wood-brown color sprinkled with yellowish dots. It is one of the night flyers. The eggs are laid in the early spring on the stalks attacked. This insect frequently becomes abundant enough to do serious damage to plants.

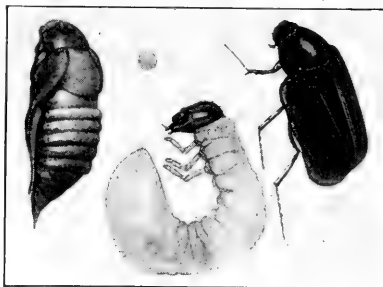
White Grubs

The young of the May beetles or June bugs are capable of devastating and frequently destroying large portions of farm crops by eating the roots. The crops commonly damaged include two of our most important staples, namely, corn and potatoes, but the beetles also attack cotton and are often extremely destructive.

These insects require three years to complete their life cycle, and usually only one brood is destructively active in

a given locality. An abundance of May beetles one year forecasts a large growth of grubs the following season.

It should be remembered that injury from white grubs, as well as from many other pests, may be forestalled by



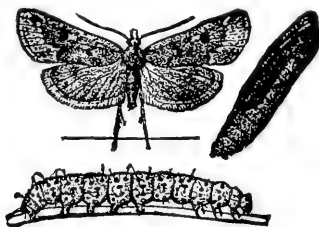
WHITE GRUBS

Showing the 3-year period of their cycle life.

the correcting of farm practices; but after cotton or any field crop has become infested it is impossible to prevent further injury to that particular crop for the current season.

The Garden Web Worm

This widely distributed and common insect is especially notable because of its occasional outbreak. Its ordinary food plants are a number of common weeds, especially pigweed and purslane, but when these are used up because



VARIOUS STAGES OF THE WEB WORM.

of exceptional abundance of the larva, the latter readily devour cultivated crops, including cotton. Web worms are especially fond of the finer and softer grasses in the south, such as buffalo grass and Johnson grass.

The mature larva, about five-eighths of an inch long, are whitish or dusky or even greenish, with black dots. They spin a loose but evidently individual web, rarely more

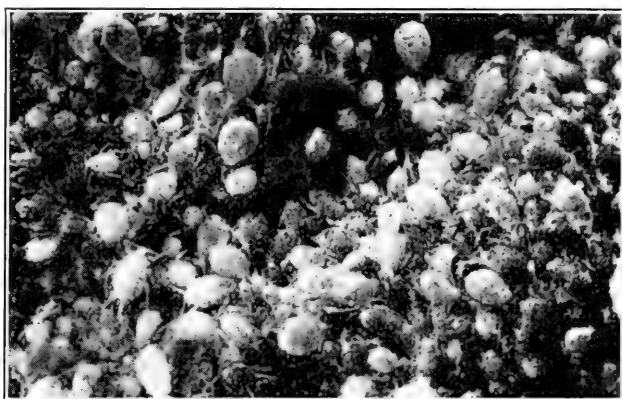
than one worm occupying the same web. This web incloses more or less of the foliage of an infected plant.

The larva are very active, feigning death when disturbed or spinning a thread and dropping to the ground, slipping out of sight in crevices or loose earth. Most of the feeding is done at night, the larva usually resting in the web by day until the last stage, when they are active during the daytime.

Plant Lice

While the cotton plant is yet young and tender, the damage which plant lice do by gathering upon the young shoots and tender leaves, and curling and distorting them, may be very considerable.

Recent investigations have shown that these insects



COTTON LOUSE

Cluster of lice on cotton leaf (greatly enlarged).

are identical with the species which occurs commonly through the south and the north upon melons and cucumbers and which derives its food from a great variety of plants besides cotton.

As the cotton plant grows larger and stronger, the work of the cotton aphid becomes of no importance, partly because of the hardier condition of the plant, but principally because the many natural enemies of the lice increase to such numbers as nearly to annihilate them.

The insects are small greenish, bluish, or brownish lice, almost unnoticeable except when they congregate in clusters on the plants, and they are too easily identified and too well known to need further description here.

PART II

DISEASES

"To know the disease is the commencement of the cure."

Cotton diseases may be classed in three general divisions according to their methods of attack:

First, diseases affecting the leaves only, such as mosaic, or yellow leaf blight, red leaf blight, and angular leaf blight.

Second, diseases which may attack any part of the plant; these include frenching, sore shin, damping off or seedling rot, anthracnose, root rot, cotton leaf blight, areolate mildew, cotton boll rot, and ripe decay of bolls.

Third, diseases which injure the roots only, such as root galls, knots, etc.

Soil and Seed-Sick Conditions

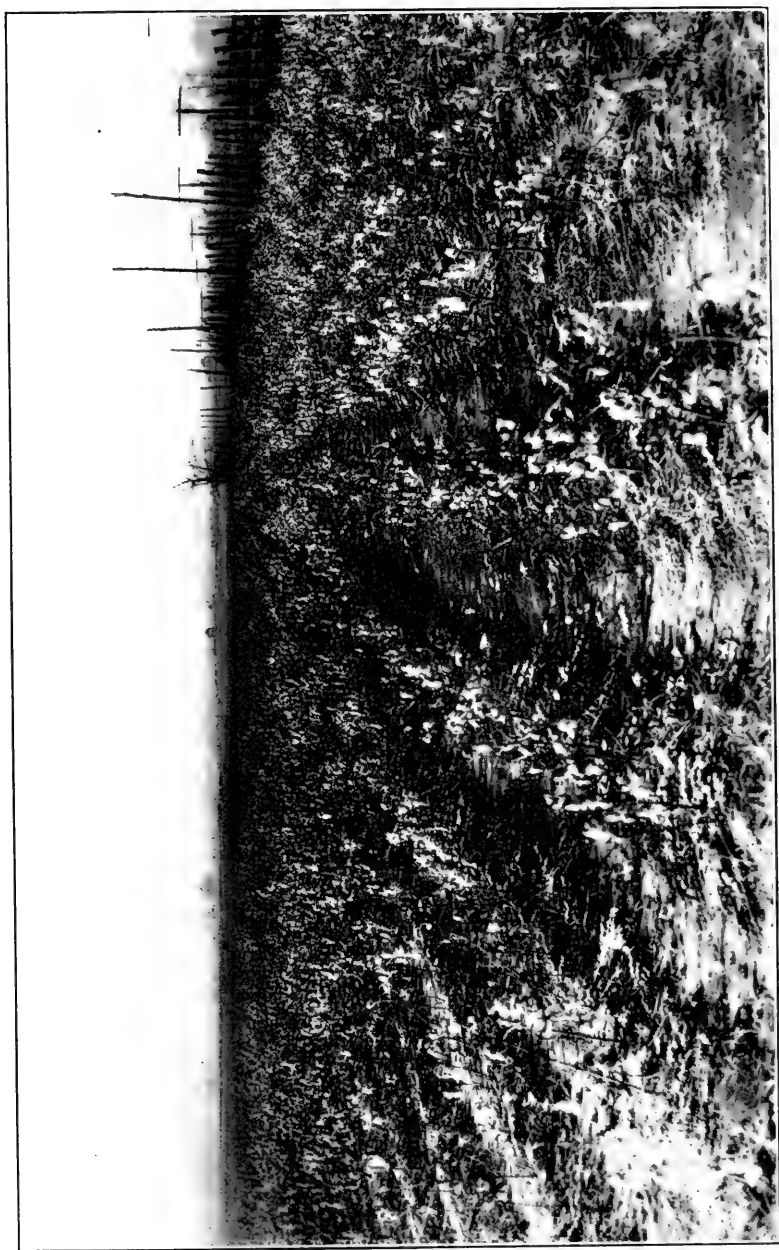
In common with other field crops cotton is subject to a number of fungous and bacterial infections which live in the soil and seed and which are manifest in various deformations, blights, leaf and stem deterioration, root decay, and general sapping of plant vitality and immaturity or disease infection of bolls.

Such infections are manifested by the rotting of root systems and a tendency to re-root above the infected parts, by spots and holes on the leaves, by discoloration and decay of the veins and stems, and by the rotting of bolls and locks.

The infections have been given various local names, most of them derived from some characteristic of the injury inflicted. As they will be commonly encountered under such designations, they are here described under those titles, all of which might be generally termed soil-sick or cotton-sick conditions.

Cotton Wilt, or Frenching

The cotton wilt, now widely distributed and yearly pre-empting more territory, is caused by a fungus that plugs the water ducts in the veins of the stem and cuts off the water supply to the parts above, always reducing the vigor of the plant and usually causing speedy death. Soil



FUNGUS INFECTION CAUSED THIS FAILURE

Poor farming methods gave the fungus a chance, and this crop was not worth picking.



COTTON WILT

A row of wilt-resistant cotton. Note non-resistant varieties of adjoining rows are entirely gone.



COTTON WILT

Cottonfield destroyed by wilt. Note few plants still surviving, but these will eventually become infected.

which produces a sick crop one year is so infected with the casual fungus as to insure a reappearance of the disease in more extensive areas in subsequent croppings. The destruction of this disease, which not only takes the crop

but impairs the usefulness of the soil as well, cannot be estimated. Its injuries can be realized only by those who have experienced its effects. Wilt has long been known by cotton planters and is now prevalent in many sections throughout the whole cotton belt.

The first appearance of the wilt is a yellowing of the lower leaves at the edges or between the main ribs, which portions may become almost white. Later they turn brown and die. A single leaf often presents the three conditions—green (healthy), yellow (sick), and brown (dead)—side by side in bands parallel to the main ribs and radiating from the leaf's stem. The dead parts may break away, leaving the leaf ragged. The upper leaves may rapidly pass through the same process as the lower ones and soon become affected over all the plant, leaving only a bare stalk. In mild cases, where the disease runs its course more slowly, the intervals between the different stages are more prolonged. In light sand the disease may progress very rapidly and consist of only two stages—the sudden wilted condition, then speedy death. The final characteristic of the disease, however, as of many other wilts, is the darkening of the affected veins, which change from the normal white to light brown or black.

Cotton Anthracnose and Boll Rot

Anthracnose is a mold-like fungus infection which invades bolls, stems, seed, and seedlings of cotton.

When a boll becomes infected, the spores spread rapidly through the lint and seed, becoming manifest at first as small round spots, dull reddish or grayish black, which gradually enlarge until often one-half of the boll is affected. Sometimes two or three spots become apparent on a single boll, and, as they spread, finally join together in one large diseased area, affecting virtually all of the boll. When these are cut open, the entire inside is found to be discolored or rotten.

When very young bolls are attacked they are sometimes killed outright, while at other times they are dwarfed or affected on one side only. Bolls which are not badly diseased or those invaded late in their development may open an apparently normal head, but the seed in these diseased locks is either destroyed completely or so inoculated



EFFECTS OF ANTHRACNOSE ON THE BOLL
Cotton bolls infected with anthracnose.

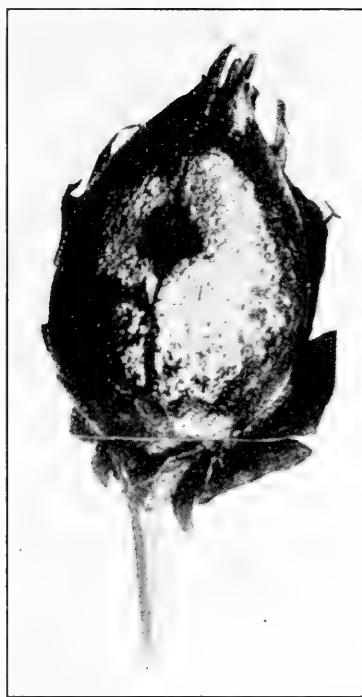


EFFECT OF ANTHRACNOSE ON THE BOLL

Cotton boll, showing only a small spot on the outside, yet the entire lock is decayed by anthracnose.

with the spores as to make them a source of infection in the succeeding crop, should they be used for planting.

The young plants from this kind of seed are often attacked and killed by these spores even before they reach the surface of the ground. Unfavorable weather causes a damping off of the young plants at the ground line. This action of the infection may be recognized by the dark-colored and diseased condition of the stem below the



EFFECT OF ANTHRACNOSE ON THE BOLL

A boll of cotton badly diseased with anthracnose and covered with a mass of pink spores.

ground. Cold, damp weather in the spring is especially likely to cause this, and under such climatic conditions the spores of anthracnose are usually prevalent and destructive.

Owing to their peculiar property of dissolving in water, the spores of fungi often become suspended in rain drops and are thus carried from infected to uninfected fields by rain and wind, and by insects and animals on whose bodies they have lodged, having been deposited by drops of rain. As the fungi cling to the stalks and live in the ground and seed and thus infect fields from year to year, recurrence of



EFFECT OF ANTHRACNOSE ON THE SEED

Diseased seedlings caused by anthracnose.

the disease condition will be noted from season to season to the final total failure of cotton on that particular field unless seed selection and crop rotation—to clear the seed and soil from the infection—are practiced.

Angular Leaf Spot

Angular leaf spot is named from the dark angular spots which appear in the leaves. It is very widespread, but rarely appears to such an extent as to attract attention. Careful observation would probably reveal it in every cotton field during the growing season from May to July and frequently later. The disease is first manifested by a watery appearance in definite spots which are bounded by the veins of the leaves. The spots are sometimes very numerous and frequently unite into one large area of infection. Often the disease follows one or more of the main

ribs of the leaf, being bounded on either side by an irregular zigzag line. In time the spots become blackish and then brown, and are frequently bordered by a blackish color where the disease has spread outward from a centrally infected spot.

The dead spots in the leaf sometimes break out, leaving many perforations with ragged edges, somewhat as often results in cotton leaf blight; the disease hastens the falling of the leaves.

In the very earliest appearance of the spots, when the watery condition is coming on, these spots swarm with bacteria; these also often occur on the plant bolls which present spots of watery appearance, and these finally terminate in rot and death. In this case the general weakness of the plant naturally extends to the boll also.

Mosaic, Yellow Leaf Blight, or Black Rust

The first signs of mosaic are yellowish spots which give the leaf a checkered appearance. These discolorations occur first in small areas, which are roughly rectangular



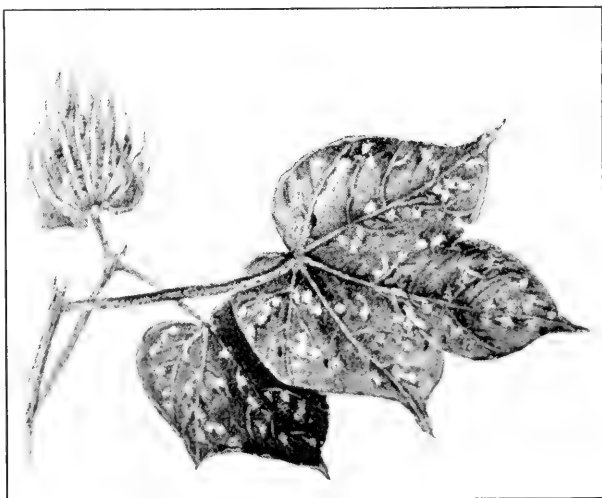
MOSAIC DISEASE, OR YELLOW LEAF BLIGHT

owing to the limitation caused by the veins and are situated at points most remote from the main feeding veins.

In later stages these weakened areas may be overgrown by various fungi. Usually the centers of these spots soon turn brown, and the brown parts enlarge and show a series of concentric markings. If very dark-colored fungi grow upon these spots, they soon become black-coated, and from this fact take the popular name black rust, which, however, bears no similarity to, or relation with, the rust of the cereals. The attack of the fungus causes the premature falling of the leaf, thus preventing the proper maturity of the plant. Losses may vary from 5 to 50 per cent, and, being widely distributed, such losses are often very heavy. It may be safely asserted that this disease cannot attack a cotton plant that is in full vigorous growth, but a sudden checking of growth and lowering of vitality from any cause will render it liable to serious injury if the weather conditions favor the growth of this fungi.

Frosty Mildew

The leaf spot caused by frosty mildew is limited sharply by the smaller veins, and bears upon the lower surface numerous colorless spores upon a colorless coating, thus lending a frosted appearance.



MILDEW OF COTTON

Showing the spots of mildew on the leaves.

As seen from above the spots are light yellow or of a paler green than the normal leaf tissue. Widespread, though not especially destructive, frosty mildew does not usually attract the attention of the planter, with the result that the damage done by this disease is most generally said to be due to the attack of some insect, or some other disease.

Red Leaf Blight

The foliage of cotton frequently presents a red coloration which is not unlike the red or brown of autumn leaves. It is of exceedingly common occurrence toward the maturity of the cotton, even where the growth is quite healthy and rank, but is of rarer occurrence in rich soils than on poor land. It is especially common on the drier uplands where the soil is worn and poor. Here it occurs quite early in the season, and cotton sometimes makes but little progress before the leaves become red.

Sore Shin, Damping Off, and Seedling Rot

Sore shin, damping off and seedling rot are names applied to a very common disease which causes young plants to rot off partially or entirely at or near the surface of the ground. There seem to be several phases of the disease. Sometimes the tissues undergo a soft rot which progresses very rapidly, the early stages not being marked by any striking color characteristic.

Primarily the disease is manifested by an ulcerous wound upon the stem near the ground, accompanied by reddening or browning of the leaves. If the ulcer enters deep into the stem so as to interfere with the stalk, it may cause death. This is of unusual occurrence, however, since a healing of the wound generally occurs before the disease has progressed too far. Infection often results from the mechanical injuries caused by tools, the bacteria gaining a foothold in these bruised spots.

Texas Root Rot

Texas root rot has been known to attack cotton in very destructive forms in Texas, Oklahoma, New Mexico, and Arizona, though it has not yet been found east of Texas. In the state of Texas in one season alone the damage caused

by the disease was estimated at \$3,000,000. Some planters regard it as a worse enemy than the boll weevil.

In this disease a few of the plants may wilt and dry up in a day. This usually occurs at or before blackening, occasionally upon plants only a few inches high. Later many plants suffer a similar fate, the result being irregular spots of disease in the fields, marked by the presence of numerous bending, dead plants. The plants wither most rapidly



COTTON ROOT ROT
Showing the root rot of cotton

on hot days, following rain, but not so rapidly in continued dry weather. Especially after a rain living plants, surrounded by dead ones, may show symptoms of the disease in the form of wartlike bodies upon the taproot. All affected plants have diseased roots marked by an injured and shrunk taproot, accompanied by depressed spots which are, at first, bordered by a reddish discoloration. The casual fungus is also apparent here, at first as a white mole, which later turns brown or yellow and finally develops a wartlike hardening. Enlargements from which new roots

are put forth often occur near the soil surface. Even the lint of the diseased plant is affected, the fibers being wider and spirals fewer and more uneven than upon healthy plants. The disease is truly of the soil, and the diseased soil-centers enlarge yearly, as in soil infection of other plants.

Cotton Root Knot, or Root Gall

Root knot of cotton and other crops is caused by minute eelworms which bore into the roots and live there. The irritation of their presence results in the formation of irregular swellings, or galls, varying in size from tiny en-

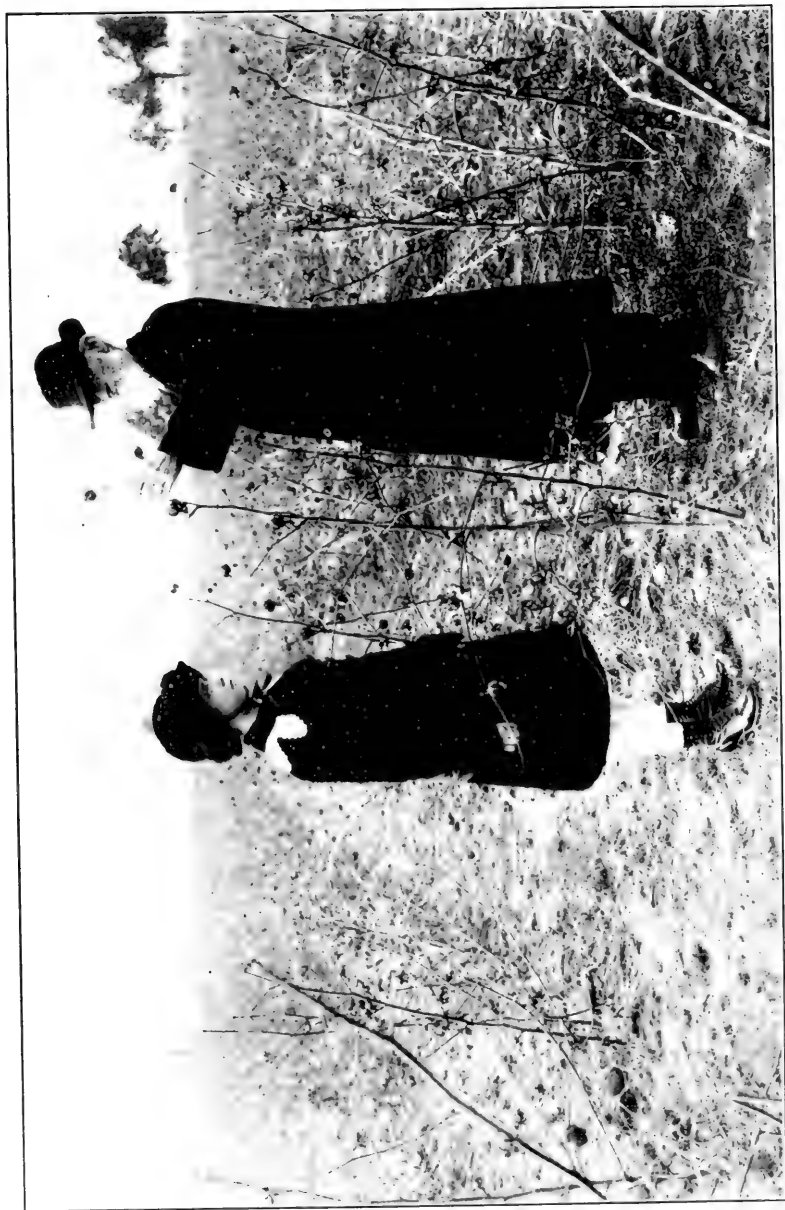


ROOT GALLS OR KNOT

Showing the galls on various parts of the root structure

largements on the small roots to knots an inch or more in diameter on the large ones.

The detection of cotton plants affected by root knot, except by an examination of the roots, is much more difficult than in the case of wilt. Diseased plants are distinctly stunted, but not appreciably deformed, as in wilt, and have



CORRECT METHODS DID THIS

To obtain plant of the height shown here, it is necessary to follow correct methods of cotton-growing, seed selection, crop rotation, etc.



A ONE-CROP FARM
Too much cotton finally results in no cotton. Crops never rotated.

a peculiar sickly yellowish-green color on both leaves and stem. In times of drought affected plants are the first to show the lack of water and may wilt slightly in the middle of the day. If such a plant is pulled carefully or, better, dug up with a shovel, the roots will be found to be covered with swellings, or galls, from the size of a pinhead to half-inch or more in diameter. If one of these knots is broken open, numerous pearly white rounded bodies about half the size of a small pinhead can often be seen with the naked eye.

When root knot occurs with wilt, which is often the case, the symptoms of both diseases are present. The plants usually all die or are so badly dwarfed that little or no cotton is produced.

Root knot is essentially a disease of light soils. Although the disease may occur on heavier soils than wilt, yet it is not as a rule serious on soils containing a large portion of clay. The places of greatest damage are usually light sandy spots or ridges in infected fields.

PART III

CONTRIBUTING CAUSES

"A field requires three things, fine weather, good seed, and a good husbandman."

A grower is often unable to explain why his crop is not as hardy or as flourishing as that of his neighbor. The answer may be his failure to follow some one or all of the simple yet necessary practices of good farming operations. His loss may be due to poor cultural methods, failure to select seed carefully, too frequent cropping of the land to the same thing, improper cultivation, or carelessness in some other fundamental. An investigation of methods often offers a clear explanation of otherwise inexplicable failures.

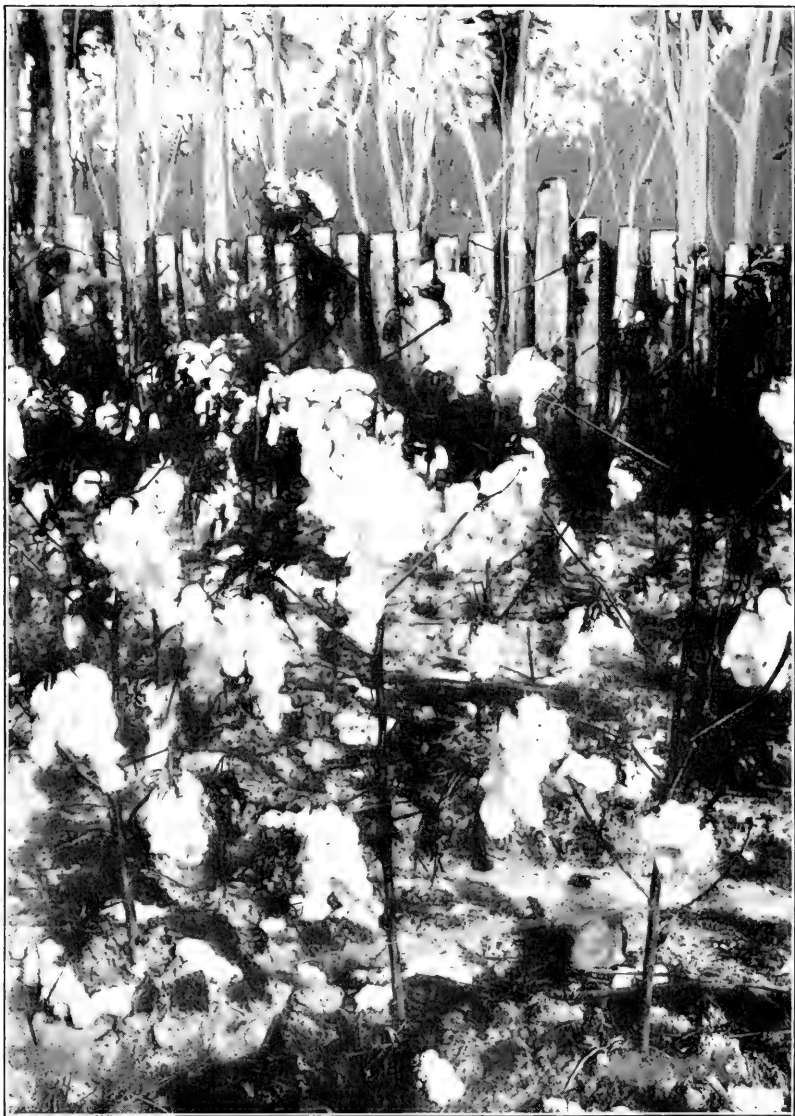
Shedding of Bolls or Squares

The shedding of bolls or squares, or their drying up while still attached to the plant, is very frequently encountered. This is almost always claimed as hail damage and may often be confused with the work of the boll worm or with punctures made by some other insect. Sometimes part of the shedding is due to the work of the boll worm, but the dropping off referred to here is a purely climatic trouble or a natural stage of the plant's development.

It occurs most frequently in extremes of either dry or wet weather or during the change from one extreme to another. It may occur to some extent under normal climatic conditions, especially if the cotton plants are too thick or the variety of cotton is one which develops a very large number of bolls in proportion to the leaf surface.

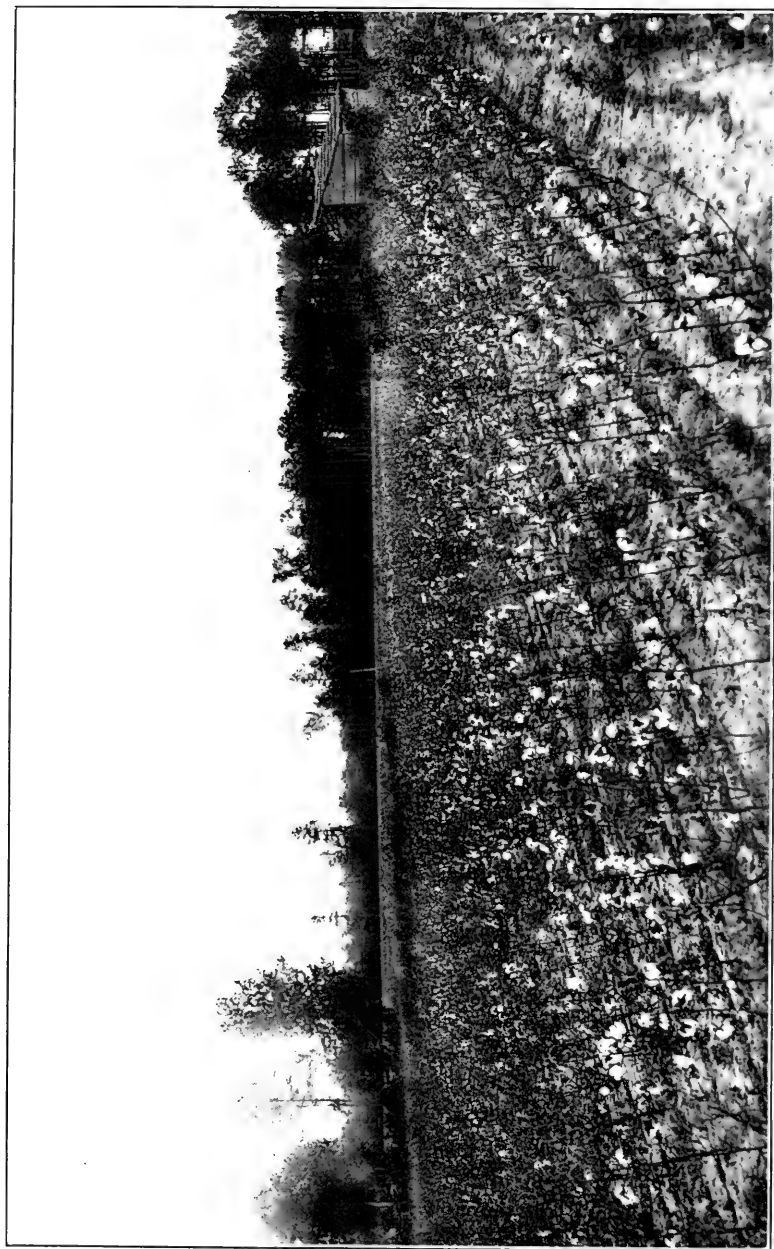
During a normal period of growth the plants put out as many boll forms as would quickly mature should favorable conditions continue. If a very dry period follows this, interfering with the supply of nutriment and moisture, a partial withholding of tissue-forming material results at a very critical period in the life of the boll, thus forcing the tissues into an unnaturally matured condition.

A long rainy season may also cause the young bolls to fall, the soil being so saturated with water as to interfere with the roots' absorption and to disturb the assimilative activity of the leaves. The falling away of the dead im-



SHOWING RESULTS OF PROPER FARMING

Thirty plants grown from selected seed in a well-prepared seed bed and in soil of good fertility.



SHOWING RESULTS OF IMPROPER FARMING

This crop did not pay the land rent. Poor seed selection, or no seed selection at all. Lack of crop rotation.

mature bolls and forms when it does occur is a useful provision of nature, since the plant is left in better condition for the gathering of the crop which does mature.

When the cotton is putting on squares or blooming, the claimant often contends that hail knocked the squares off, when it is a matter of common knowledge that cotton will ordinarily throw off two or three times as many squares as it will put on bolls. It is as natural for cotton to shed its squares as it is for the cherry and apple tree to shed their blossoms.

The more or less complete separation of the squares at the line of division between the healthy and dying portion depends upon the point of attachment of the bloom to the stem, and for this reason they sometimes remain attached to the plant though withered and lifeless.

Climatic Conditions

During all stages of its growth the cotton plant is subject to destruction by various climatic conditions, each of which resembles hail damage very closely. Unless an adjuster is familiar with these and prepared to ascertain the true cause of the damage, a dishonest claimant will use every effort to convince the adjuster that these are losses for which he should be paid under his hail contract.

Sand Storms

When the tender plants have pushed their way out of the ground and before they have become hardy enough to withstand such damage, the action of the wind sifting sand across the land will completely cut off young plants and often cause total losses to entire fields. On close examination the shifting of the sand and the consequent damage caused can be plainly pointed out to the claimant contending for an unfair allowance.

Action of Rain

Hard, beating rains, accompanied by high winds, will also cut off the tender plants, and a claimed hail loss is the inevitable result. Unusual care must necessarily be exercised in the adjustment of such losses to separate this loss properly from that actually caused by hail. Another

effect of beating rains is to pack the sandy soil too firmly around the young cotton plant, "choking" it off and retarding or totally stopping the growth of the stalk. In either event a sickly stalk or a dead one results.

When the plant is more mature and the bolls open, a hard rain will cause the cotton to shred out and hang in strings from the plant. Such injury often resembles and has been erroneously claimed as hail damage. The present form of "Open Cotton" clause excluding liability after the bolls have opened was adopted on this account.

Seed Selection for Cotton

But few crops are as susceptible to material loss from lack of proper seed selection as is cotton. The inevitable results of indifferent methods of seed selection are manifest in a sickly stalk, fungous infection, inferior quality, and subnormal yield.

Where some system of careful selection is not practiced by the grower, such conditions are almost always evident in the growing crop. A great variation is always noticeable in such fields, one stalk having a large number of bolls, while another, growing by its side, will be almost barren.

If a seed-breeding plat is kept by the grower, isolated from the general fields to prevent an intermingling of pollen and possible fungous infection or insect infestation, and careful elimination is made thereon from year to year, the results are bound to show in the field, and the higher grading of plants thereby obtained will eliminate the cause of many illegitimate claims now made for hail damage.

The use of adapted seed instead of the imported variety results in a stronger, healthier growth of cotton which is less affected by either hail or other climatic or disease conditions.

There is one source of infection of cotton seed that is not applicable to any of the other crops, and that is the danger of impurities or fungi becoming mixed with the seed when it is ginned. In many places a special device is in use by the ginner to guard against infection or mixing of seed, but, even with such precaution, carelessness in cleaning the saws will inoculate the seed cotton with anthracnose or other bacterial disease. The grower who has selected his

seed and had it ginned in a presumably clean gin is unable to believe that the resultant loss is due to any other cause than a hailstorm. Inquiries as to methods of seed selection and ginning are never out of order if the loss appears to be due to a fungus infection or boll-rot condition.

Crop Rotation

To restore the necessary quantity of organic matter to the soil, a system of rotation is essential. Where some proper cropping scheme is not followed, poor yields, total failures, or disease-infected fields are commonly encountered regardless of the fact that cotton is one of the few crops that does not exact a heavy annual toll from the soil.

Cotton can be planted more years in succession on the same plot of ground without completely depleting the fertility than can, possibly, any of the other staple crops; yet extended cropping of cotton will in time wear away the best soil or permit it to become fungus-ridden. When any form of fungus infection has gained a footing, rotation is the only means of elimination of this soil-sick condition.

The depleted field is the first to show the effects of unfavorable climatic conditions, and deficiencies of moisture are first seen in a field that has long been planted to cotton alone.

Losses from Deep Cultivation

While normally the cotton plant has a strong, branching taproot penetrating deeply, the root system is subject to much modification, owing to the nature of the soil and the subsoil. In many instances the taproot may be absent, while in other instances a well-developed taproot has often been traced in sandy soil and subsoil to a depth of two to three feet without coming to its end. In heavy clay loam only one plant out of twenty-one was found which had a well-developed taproot over 9 inches long. In either kind of soil the lateral roots begin about 3 inches below the surface of the soil and spread out in all directions, most of them being within 9 inches of the surface. Most of the lateral roots originate at $1\frac{1}{2}$ to 2 inches below the surface of the ground, and their direction is such that deep cultivation would break a large proportion of the roots.

Losses caused by too deep cultivation of the cotton

plant are often attributed to some other cause of damage. The sickly appearance of a plant whose roots have been broken by a cultivator shovel closely resembles damage caused by insects working on the roots, by cotton-sick soil, or by lack of moisture, and hail is quite frequently blamed for such conditions. When hail damage is claimed on cotton plants that have a wilted appearance, it is well to examine the soil to determine the depth of the preceding cultivation.

Summary of Losses to Cotton—What to Look For and Where to Find It

LOSSES TO ROOTS		LOSSES TO LEAVES			
NATURE OF DAMAGE	CAUSED BY	LOOK FOR	WHERE FOUND	APPEARANCE OF LOSS	
Dying Plant	White Grub	Larva (Worm)	Feeding on Roots	Roots eaten away.	
	Root Rot	Diseased Roots	On Roots	Roots decaying, especially tap root.	
	Root Knots or Galls	Scales or Knots	Throughout Root System	Knotty or diseased roots.	
	Deep Cultivation	Severed Roots		Plant wilted and dying. Properly cultivated fields adjacent not injured.	
Holes in Leaves and Shredded Leaves	Cotton Boll Worm	Larva (Worm)	In Bolls or on Leaves	Bolls burrowed and leaves eaten.	
	Cotton Leaf Worm or Army Worm	Larva (Worm)	On Leaves or Stems	Leaves eaten, veins sometimes furrowed.	
	Leaf Feeding Caterpillar	Caterpillar (Worm) in leafy sacks	On Leaves	Leaves eaten away or rolled into sacks, caterpillar feeding inside.	
	Grasshoppers	Larva and Web	Lower part of Stalk	Any part of plant damaged.	
	Garden Web Worm	Cluster of very small Lice	On Leaves, generally on under side	Wilted and dying plant.	
	Plant Lice	Wilted Plant	Entire Plant	Leaves yellowing in spots.	
	Cotton Wilt or Frenching	Decayed and blackened spots	On Leaves, Stems and Bolls	Plant dying without apparent cause. Yellowish fungi often in evidence.	
	Anthrachnose	Rusted or Yellow Leaves	Leaves	Leaves spotted, discolored and dying.	
	Mosaic Yellow Leaf Blight or Black Rust	Reddish spots	Leaves	Leaves yellow or black spotted, such spots sometimes falling entirely out.	
	Red Leaf Blight	Angular Spots	Leaves	Changing from natural to Autumnal color.	
	Angular Leaf Spot	Mildewed or Frosted appearance	Leaves	Angular spot bounded by the veins.	
	Frosty Mildew		Leaves	Frosty or Mildewed coloring of leaves.	

Summary of Losses to Cotton—What To Look For and Where to Find It—Continued

NATURE OF DAMAGE	CAUSED BY	LOOK FOR	WHERE FOUND	APPEARANCE OF LOSS
LOSSES TO BOLL	Injured Bolls	Small Beetle or Larva (Worm)	Larva inside Boll, Weevil between Bolls and Squares	Boll furrowed and lint damaged.
		Larva (Worm)	Inside Boll or on Plant	Leaves eaten and Bolls furrowed.
	Leaf Feeding Caterpillar	Larva (Worm)	Leaves or Bolls	Similar to Boll worm damage; infrequent.
	Sharp Shooter	Leaf Hopper, Red Bug or Cotton Stainer	On any part of Plant, including Boll	Small punctures in Boll; Bolls small or immature.
	Anthraxnose and Boll Rot	Rotting Bolls	In or on Bolls	Outside of Boll may not be affected. Inside a decaying mass.
	Angular Leaf Spot	Spotted Bolls	On Boll covering	Outside of Boll decaying, immature or stunted Bolls.
	Falling Bolls or Squares	Larva (Worm)	At Base of Plant	Bolls and squares falling; this is a natural period of growth.
	Cutworm	Larva (Worm)	On Boll covering	Cutting plant entirely off eventually.
LOSSES TO STALK	Cornstalk Borer	Larva (Worm)	In Stalk near Ground	Top wilting and dying. Plant breaking over. Look for round hole in stalk, near ground line.
	White Grub	Common White Grub	Feeding on Roots	Roots eaten away and plant dying.
	Web Worm	Larva and Web	On or near Roots	Wilted and dying plant.
	Improper Cultivation	Depth of Cultivating		Cotton dying from roots being severed. Adjacent fields not injured.
	Wilt	Wilted Stalk and discoloration	On Plant	Stunted and wilted plants.
	Fungus	Spores of Fungi	On Roots, Stalks and Leaves	Closely resembles wilt.
	Root Rot and Root Knots	Spores of Fungi	On Roots	Unhealthy or dying plant.
	Sore Shin or damping off	Ulcerous Wounds	Near Ground	Young plants rotting off partially or entirely at ground line.

NOTE:—Lack of moisture, soil deficiencies, absence of rotation and improper cultural methods are first apparent by wilting and dying of leaves.

NOTE:—Improper seed selection, lack of crop rotation, poor cultural methods and deficient soil are evidenced by a stunted or dying plant. Sand storm or hard, beating rains will sever the young stalks or pack the soil, causing death.

“A single fact is worth a shipload of argument.”

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